VIP Program: eStadium

Wireless Subteam

Recommendation of North End Zone Concession Area

Wireless Network

For Bobby Dodd Stadium

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Introduction

The following proposal discusses two solutions for designing a wireless mesh network for Bobby Dodd Stadium. A mesh network is necessary in the Bobby Dodd stadium to provide Wi-Fi access to clients and to relay data from the cluster head of the sensor network. The first option recycles more hardware already in the possession of the eStadium team and is more cost-efficient to implement. However, it is a temporary solution and serves better as a test bed. The second option requires more new hardware in the form of new router boards or custom PC's, wireless cards, and wireless embedded devices supplied by Texas Instruments. The second option offers a longer life cycle and is more flexible for future modifications.

Mesh networks consist of a gateway and mesh nodes that operate on an IEEE 802.11a network. The first mesh node receives the signal from the gateway and then relays the signal to the next node. The throughput of a mesh network degrades by approximately half with each hop through the network. Therefore, no more than three hops are implemented for the mesh network designs.

Network Topology

The North end zone concession stand area wireless network will include the backbone for the sensor network, the backbone for the wireless network, and provide wireless coverage for end users. Network accessibility will come from the data closet in the south east corner of the concession area. A gateway will be needed to get network accessibility from the data closet to the new networks. Nodes of the wireless mesh network will be placed on the columns in the concession area to extend coverage for the wireless data network and to extend the sensor network backbone.

The gateway will need an Ethernet interface to connect to the switch located in the data closet. This Ethernet connection will provide network access to the entire deployment. Two wireless interfaces are essential for the gateway while a third could be used to increase the coverage area of the wireless data network. A single wireless interface on the gateway will be used to forward data on the backbone of the wireless data network over 802.11a (5 GHz). The second wireless interface is needed to forward sensor data over 802.11b/g using channel 6 for the backbone of the sensor network. The optional third wireless interface could be used to broadcast data over 802.11b/g on channel 1 or 11 to end users of the eStadium network.

A node of the wireless mesh network will need to consist of 3 wireless interfaces. The first wireless interface will be used for the Mesh Local Area Network (MLAN). This will be the backbone of the wireless data network which will use 802.11a (5 GHz) to transmit data. The second wireless interface will be used for the Sensor Backbone Local Area Network (SBLAN). This will be the backbone of the sensor network which will use 802.11b/g on channel 6 to forward data. The SBLAN will have a dedicated wireless network to ensure better reliability and throughput for the data received from the sensors. The third wireless interface in each node will be used to forward data from the MLAN to end users of eStadium. This will be done over 802.11b/g using channels 1 or 11.

Hardware Options

Router boards are designed with different configurations and options including number of mini-PCI slots, number of Ethernet ports, and USB ports. All the models come with sufficient processing power and memory necessary for the eStadium network. The number of mini-PCI slots limits the number of wireless cards that can be added to the router board. USB ports will make installing Linux much easier. Without USB ports, Linux will be installed over Ethernet. Ethernet ports are required for connecting to wired networks.

Table 1. Router board specifications.

Model	CPU	Memory	mini-PCI	Ethernet	PoE	USB	Memory Expansion	Price
RB411	300MHz	32MB	1	1	Yes	0	None	$49.00
RB433	300MHz	64MB	3	3	Yes	0	MicroSD	$99.00
RB433AH	680MHz	128MB	3	3	Yes	0	MicroSD	$149.00
RB433UAH	680MHz	128MB	3	3	Yes	2	MicroSD	$165.00
RB435G	680MHz	256MB	5	3	Yes	2	MicroSD	$189.00
ALIX2D2	500MHz	256MB	2	2	Yes	2	Compact Flash	$129.00
ALIX3D3	500MHz	256MB	2	1	Yes	2	Compact Flash	$132.00
ALIX3D2	500MHz	256MB	2	1	Yes	2	Compact Flash	$129.00
net4526-30	133MHz	64MB	2	1	Yes	0	Compact Flash	$135.00

Figure 1 shows the different models of router boards that we looked at and their specifications that we found important. With one mini-PCI slot, a router board can use one wireless card which can connect to two patch antennas as seen in Figure 1.

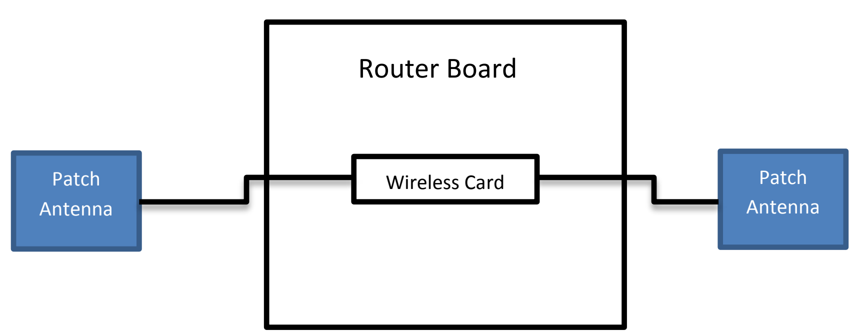


Figure 1. Router board with one mini-PCI slot.

The more expensive router boards have multiple mini-PCI slots for multiple wireless cards. Two antennas can be attached to each wireless card. Figure 2 shows a router board with three wireless cards and six antennas.

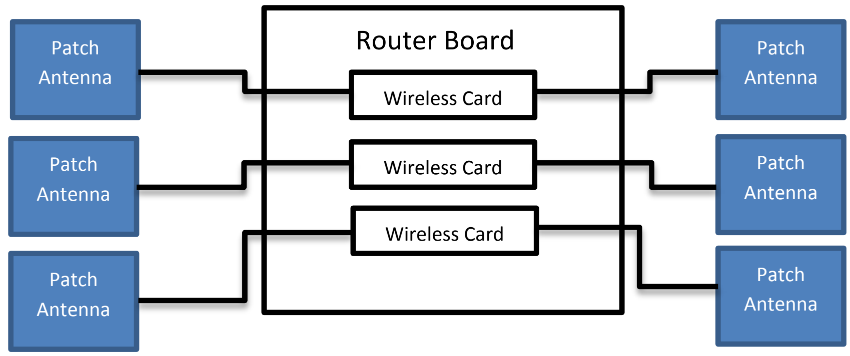


Figure 2. Router board with 3 mini-PCI slots.

A custom built PC could be used in place of the router board. The PC can be designed with low grade solutions for the CPU, RAM, memory, and power supply. The main variable for the motherboard is the number of PCI slots which matches to the number of wireless cards. Figure 3 shows a layout of a custom PC solution.

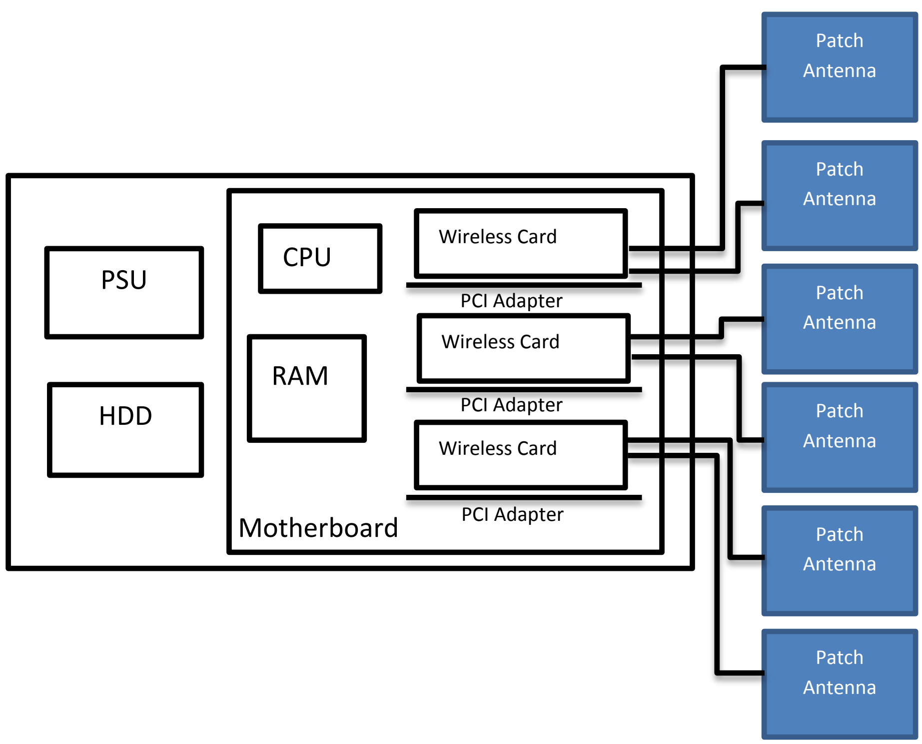


Figure 3. Custom PC design as a mesh node.

Table 2 shows the prices and specifications for a custom PC. The motherboard has 3 PCI slots to allow for multiple wireless cards. The custom PC solution costs approximately the same price as one of the router boards. Therefore, the router board was chosen for both solutions since it is an integrated solution and has a smaller form factor.

Table 2. Custom PC specifications and prices.

	Motherboard	CPU	Memory	PSU	HDD	Total
Specifications	3PCI Slots	2.8GHz	1GB	350W	40GB	
Price	$50.00	$40.00	$9.00	$30.00	$20.00	$149.00

The wireless cards that are needed for the router board are designed with three main differences: output power, WiFi standard, and Connector type. Table 3 shows the prices and specifications for various wireless cards.

Table 3. Wireless cards specifications and prices

Model	WiFi Mode	Output Power	Connector	No. of Connectors	Price
R52	abg	19dBm	uFl	2	$49.00
R52H	abg	25dBm	uFl	2	$59.00
R52Hn	abgn	25dBm	MMCX	2	$59.00
R52nM	abgn	23dBm	MMCX	2	$59.00

A WiFi embedded system that could be connected to the cluster head as part of the SBLAN is a Texas Instruments WL1271 board. This is an embedded device that has a 1 GHz ARM processor, 256 MB of RAM, a 3.7" touch screen, and an 802.11b/g/n integrated wireless card with a uFl connector for an external antenna.

Adapters will be needed in order to connect the Cisco patch antennas to the wireless cards. Depending on the wireless card, two different adapters could be used.

Table 4. Adapter Specifications and Prices

Model	Type	Price
ACUFL	uFl to Nfemale	$15.00
ACMMCX	MMCX to Nfemale	$15.00

The Linksys WRT160NL access point could be used along side the custom PC or router boards. The WRT160NL operates on the 802.11b/g/n standard at the 2.4GHz frequency range. Two Cisco patch antennas can be attached to the AP.

<u>Network Design</u>

The first option for the network design uses a combination of router boards and access points. The gateway will consist of one router board with a single mini-PCI slot and a Linksys WRT160NL access point. The only router board in table 3 with one mini-PCI slot is the RB411. It also has an Ethernet port which will be connected to a switch in the data closet to give network access. The wireless card on the

RB411 needs to have 802.11a capabilities and have a high output power. The R52Hn was chosen for these reasons. The wireless card on the router board will be broadcasting the wireless backbone. To broadcast the sensor network backbone, the access point will be used. It will operate on the 802.11b/g standard using channel 6. The WAN port on the access point will also be connected to the switch to give it network access. The gateway is priced at 120 dollars not including the access point and patch antennas since nine access points and eight antennas have been purchased. Eventually addition APs and antennas will need to be purchased for future deployments in other parts of the stadium.

The mesh nodes will be a combination of a router board and two access points. The WRT160NL and RB411 will also be used for the mesh nodes. The router board will operate on the 802.11a standard and will be forwarding data back to the gateway. The Ethernet port on the router board will be connected to an access points switch in order to give the access point network access. The access point will then broadcast the wireless network for the end users to connect to. The second access point will be used as a node in the sensor network backbone. It will operate on the 802.11b/g standard using channel 6 so that it can pass data to the sensor network backbone access point connected to the switch in the data closet. The multiple mesh nodes in the network design will be identically configured. The mesh node is priced at 120 dollars excluding the access points and patch antennas. Once again, additional APs and antennas will need to be purchased for future deployments.

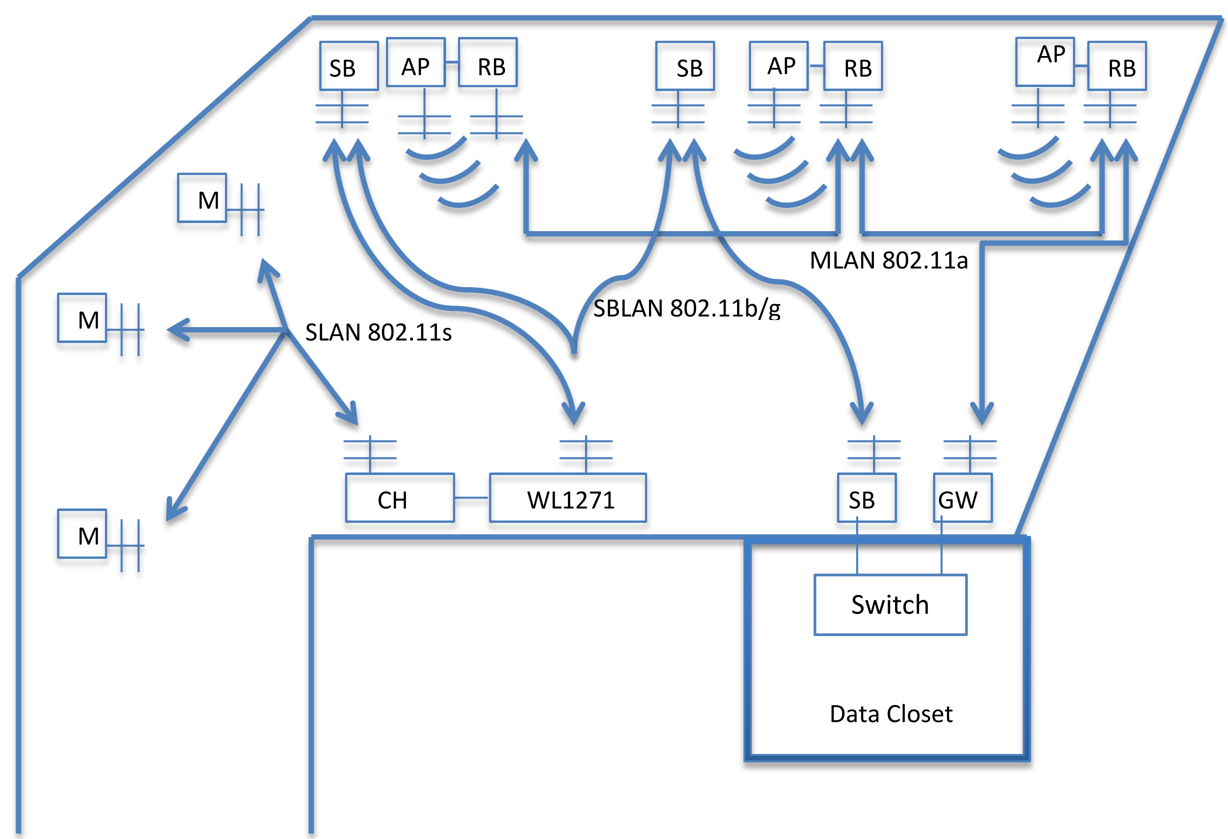


Figure 4. Network design option one for the north end zone concession area.

Figure 4 shows the network design for the SLAN, SBLAN, MLAN, and WLAN. The SLAN operates on the 802.11s standard at the 2.4 GHz frequency range. The SBLAN operates on the 802.11b/g standard on channel 6 at the 2.4 GHz frequency range. The MLAN operates on the 802.11a standard at the 5 GHz frequency range. The WLAN operates on the 802.11b/g standard on channels 1 or 11 at the 2.4 GHz frequency range. In the SLAN section of the figure, the clusterhead is designated by CH and the motes are designated by M. In the SBLAN section, the sensor network backbone access point is denoted by SB. In the WLAN section, the wireless data network access point is denoted by AP. In the MLAN section, the wireless data backbone is denoted by RB.

The second option for the network design uses only router boards with multiple wireless interfaces to operate on the SBLAN, MLAN, and WLAN. The RB433AH router board with 3 mini-PCI slots was chosen for the design. The R52Hn was chosen again for its 802.11a/b/g/n capabilities and high output power. This option will require three of the R52Hn wireless cards per RB433AH. The hardware of the gateway and mesh nodes are identical while the software is configured differently for the different functions. The first wireless interface will be set to 802.11a and will operate as the wireless network backbone. The second wireless interface will act as the sensor network backbone and will operate on the 802.11b/g standard using channel 6. A third wireless interface will broadcast the wireless data network for the end users. The gateway/mesh nodes are priced at 330 dollars not including any addition antennas needed for deployment. Extra patch antennas will need to be purchased since this design utilizes 9-12 antennas depending on the desired coverage area. One antenna will be used for the SBLAN, one antenna will be used for the MLAN, and one or two antennas will be used for the WLAN.

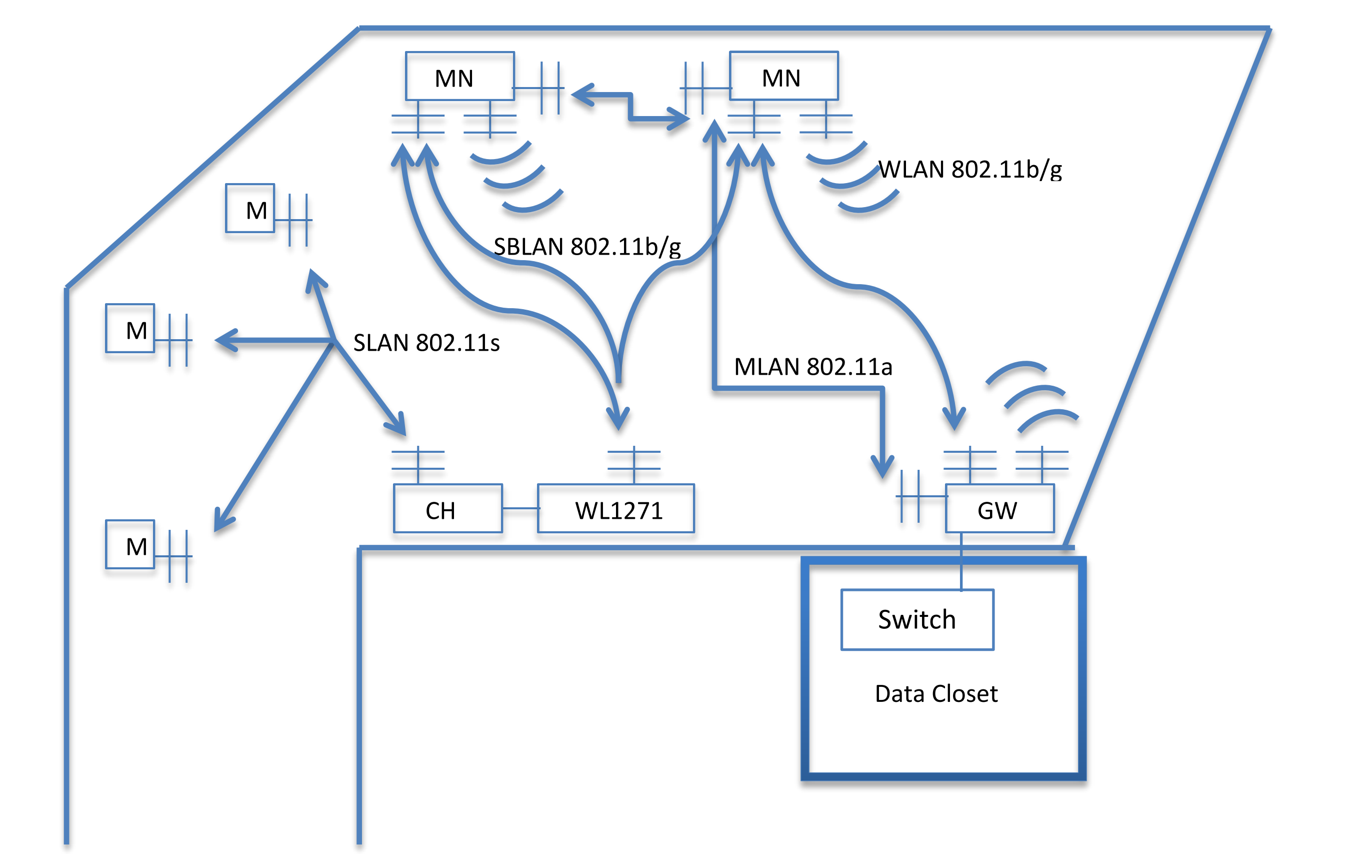


Figure 5. Network design option two for north end zone concession stand area.

Figure 5 shows the network design for the SLAN, SBLAN, MLAN, and WLAN. The SLAN operates on the 802.11s standard at the 2.4 GHz frequency range. The SBLAN operates on the 802.11b/g standard on channel 6 at the 2.4 GHz frequency range. The MLAN operates on the 802.11a standard at the 5 GHz frequency range. The WLAN operates on the 802.11b/g standard on channels 1 or 11 at the 2.4 GHz frequency range. In the SLAN section of the figure, the clusterhead is designated by CH and the motes are designated by M. In the other networks, the mesh nodes are designated by MN and the gateway is designated by GW.

Recommendation

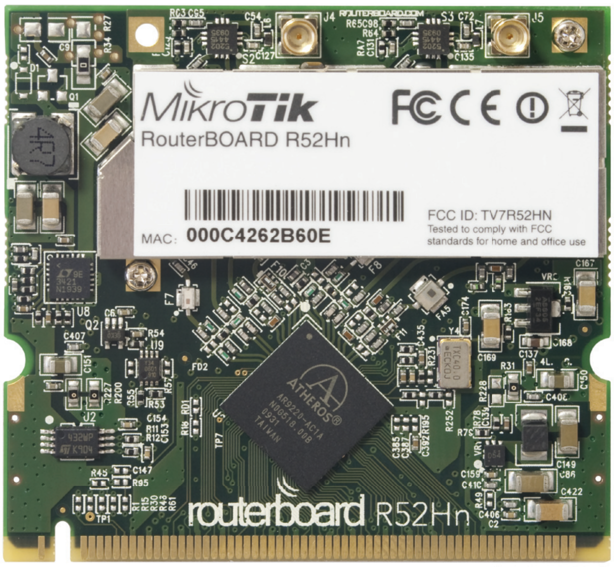
Option two provides a better solution for the wireless network and sensor network backbone in the north end zone concession area. The biggest problem with technology is how quickly it becomes obsolete. Option two leaves room for expansion and improvement to the network as option one does not. When the PoE cable is eventually run to the nodes, the wireless cards that were originally being used for the backbone can be switched in software to broadcast the wireless data network. With extra wireless interfaces broadcasting the wireless data network, newer standards such as 802.11n can be utilized which will improve throughput. This will provide more thorough coverage as well as increasing the amount of users that the network will be able to handle. Since the router boards are equipped with PoE, only a single cat5 cable will be needed at each node. To eliminate the mesh network in option one, multiple cat5 cables will need to be run to each node increasing cost in the future.

Option two provides a solution that is physically smaller and more compact. This will help keep the impact of the deployment to a minimum while still providing quality of service. Option two is physically smaller due to the fact that is it a much more integrated solution. In option one, there are many different units that are hooked together to create the mesh network. Whenever multiple pieces are being connected, it provides more places for things to malfunction and therefore can be a more unreliable network. In conclusion, we recommend that option two be deployed as it uses specialized hardware which leaves room for expansion in the future and keeps the overall footprint of the deployment to a minimum.

An important consideration is the price to deploy in the north end zone concession area and also the price for future deployments where all the equipment needs to be purchased. Option one can be deployed in the North end zone concession area for a total cost of $405 and future deployments can be purchased for $410 per node. Option 2 can be deployed in the North end zone concession area for a total cost of $1125 and future deployments can be purchased for $825.

Appendix A: Data Sheets

RouterBOARD R52Hn



802.11a/b/g/n dual band miniPCI card

- Dual band IEEE 802.11a/b/g/n standard
- Output Power of up to 25dBm @ a/g/n Band
- Support for up to 2x2 MIMO with spatial multiplexing
- Four times the throughput of 802.11a/g
- Atheros AR9220, chipset
- High Performance (up to 300Mbps physical data rates and 200Mbps of actual user throughput) with Low Power Consumption
- 2 X MMCX Antenna Connector (J4 - Chain 0)
- Modulations:
  OFDM: BPSK, QPSK, 16 QAM, 64QAM
  DSSS: DBPSK, DQPSK, CCK
- Operating temperatures: -50ºC to +60ºC
- Idle power consumption 0.4W
- Max power consumption 7W
- MiniPCI IIIA+ design (3mm longer than MiniPCI IIIA)
- 1.5mm heatsink, 3mm RF shield thickness
- ±10KV ESD protection on RF ports

RouterBOARD R52Hn miniPCI network adapter provides leading 802.11a/b/g/n performance in both 2GHz and 5GHz bands, supporting up to 300Mbps physical data rates and up to 200Mbps of actual user throughput on both the uplink and downlink. 802.11n in your Wireless device provides higher efficiency for everyday activities such as local network file transfers, Internet browsing, and media streaming. R52Hn has a high power transmitter, bringing you even more range.

802.11b	RX Sensitivity	TX Power
1Mbit	-93	24
11Mbit	-93	24
802.11g		
6Mbit	-94	25
54Mbit	-81	22
802.11n 2.4GHz		
MCS0 20MHz	-94	25
MCS0 40MHz	-92	24
MCS7 20MHz	-78	21
MCS7 40MHz	-75	20

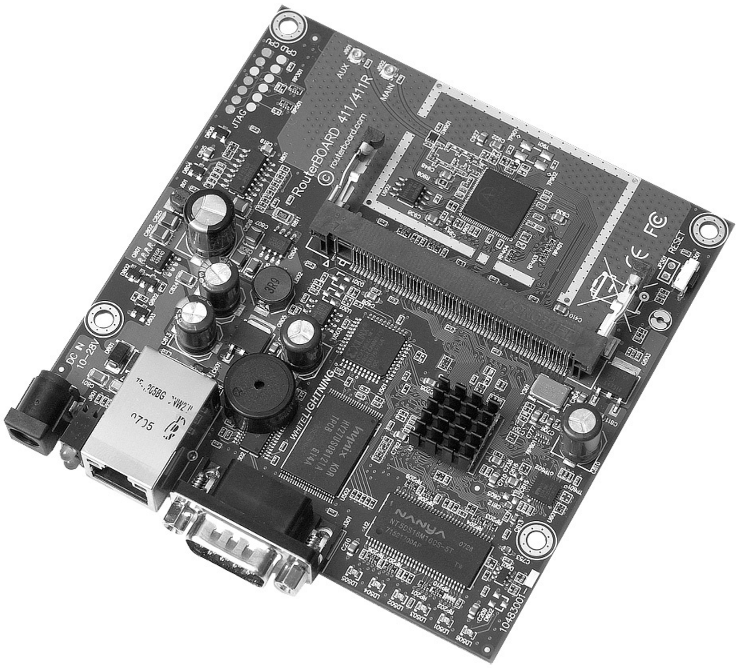
802.11a	RX Sensitivity	TX Power
6Mbit	-97	25
54Mbit	-80	21
802.11n 5GHz		
MCS0 20MHz	-97	24
MCS0 40MHz	-92	22
MCS7 20MHz	-77	18
MCS7 40MHz	-74	17

Data Rates

802.11b	
	11Mbps; 5.5Mbps; 2Mbps; 1Mbps
802.11a/g	
	54Mbps; 48Mbps; 36Mbps; 24Mbps; 18Mbps; 12Mbps; 9Mbps; 6Mbps
802.11n	
20MHz	1Nss: 65Mbps @ 800GI, 72.2Mbps @ 400GI (Max.) 2Nss: 130Mbps @ 800GI, 144.4Mbps @ 400GI (Max.)
40MHz	1Nss: 135Mbps @ 800GI, 150Mbps @ 400GI (Max.) 2Nss: 270Mbps @ 800GI, 300Mbps @ 400GI (Max.)

RouterBOARD 411

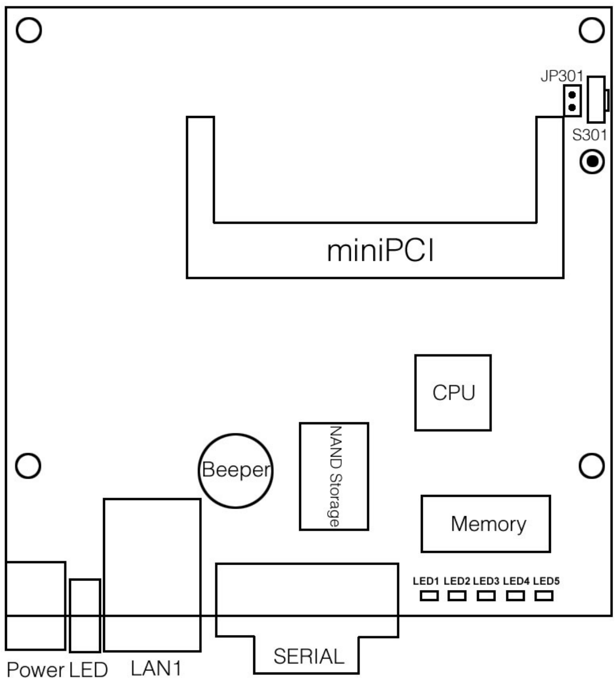
Quick Setup Guide and Warranty Information



Assembling the Hardware

First use of the board:

- Insert the MiniPCI card. RouterBOARD 411 provides one MiniPCI slot on the top of the board
- Connect antenna cables to the MiniPCI card
- Install the board in a case and connect other peripherals and cables.
- Plug in power cable to turn on the board.



Powering

The board accepts powering from either the power jack or the LAN1 Ethernet port:

- direct-input power jack **J7** (5.5mm outside and 2mm inside diameter, female, pin positive plug) accepts 9..28V DC (overvoltage protection starts at 28V).
- LAN1 Ethernet port **J8** accepts 9..28V DC input (at the board; higher voltage needed to compensate for power loss on long cables; at least 18V suggested) from non-standard (passive) Power over Ethernet injectors (no power over datalines). The board **does not** work with IEEE802.3af compliant 48V power injectors.

The maximum output of the power supply available for extension cards is normally 10W (3.0A).

Booting process

First, RouterBOOT is started. It displays some useful information on the onboard RS232C asynchronous serial port. The serial port is set by default to 115200bit/s, 8 data bits, 1 stop bit, no parity. **Note** that the device does not fully implement the hardware (RTS/CTS) flow control, so it is suggested to try to disable hardware flow control in the terminal emulation program in case the serial console does not work as expected, and if it does not help, make a new cable using the pinout given in the User's manual. The loader may be configured to boot the system from the onboard NAND, and/or from network. See the respective section of User's manual on how to configure booting sequence and other BIOS parameters.

DHCP or BOOTP (configurable in loader) protocols allow the RouterBOARD 411 series board to get an initial IP address, and provide the address of a TFTP server to download an ELF boot image from. It is especially useful for software installation. See the User's manual for more information and protocol details. Note that you must connect the RouterBOARD you want to boot and the BOOTP/DHCP and TFTP servers to the same broadcast domain (i.e., there must not be any routers between them – they must be on the same Ethernet switch).

Extension Slots and Ports

- One Ethernet port, supporting automatic cross/straight cable correction (Auto MDI/X), so you can use either straight or cross-over cables for connecting to other network devices. The Ethernet port accepts 9..28 V DC powering from a passive PoE injector.
- One MiniPCI Type IIIA/IIIB port with 3.3V power signaling.
- DB9 RS232C asynchronous serial port.

Operating System Support

Currently tested operating system is MikroTik RouterOS (starting from version 3).

Copyright and Warranty Information

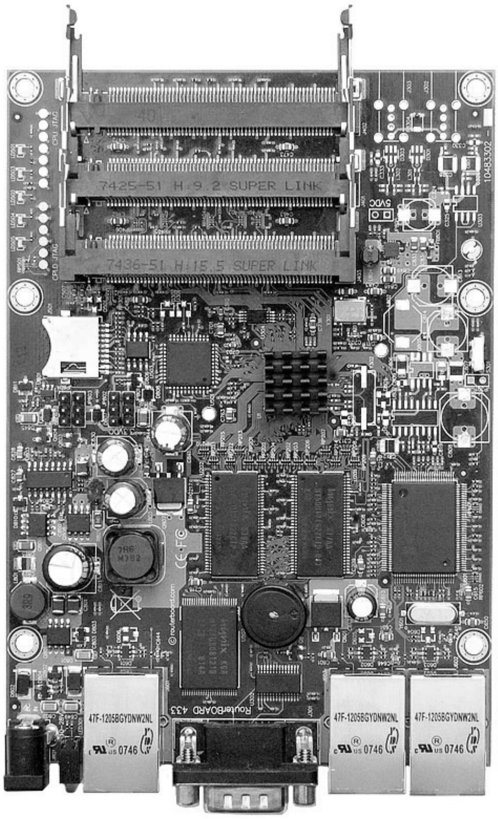
Hardware. MikroTikls SIA warrants all RouterBOARD series equipment for the term of one year from the shipping date to be free of defects in materials and workmanship under normal use and service. All parts will be repaired or replaced with similar or functionally equivalent parts by MikroTikls SIA during the warranty term, except in case the returned parts have mechanical, electrical or other accidental or intended damages caused by improper use or due to wind, rain, fire or other acts of nature.

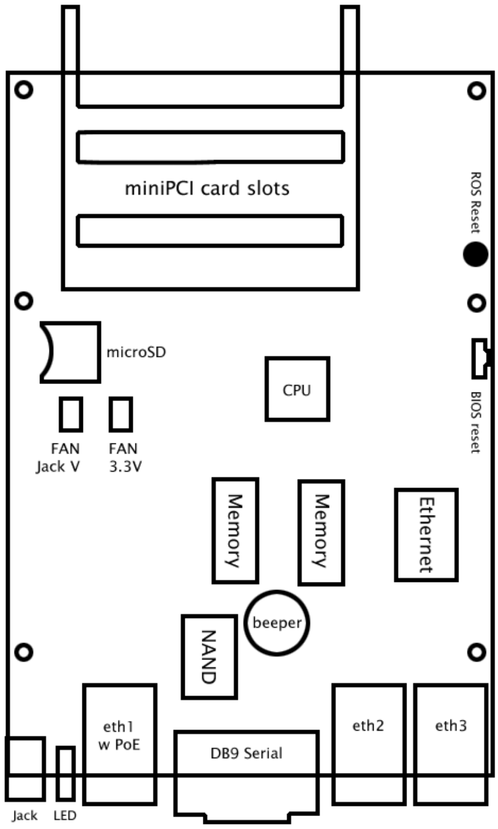
Parts (or systems) must be shipped pre-paid to our facility in Riga, Latvia. All items must have a Return Material Authorization (RMA) which you can get by contacting us via email, telephone or fax. RMA must be printed, signed, and enclosed with the shipment, also the RMA number must be written on the package itself. Parts sent without following the proper procedure will be treated as those not to be repaired or replaced due to the above mentioned conditions. Items proved to be free of defects in our lab will be returned to the customer at the customer's expense. Those that do meet the warranty repair requirements will be repaired or replaced, and returned to the customer's location at our expense, extending the warranty term for the time the items are being shipped to and from our facility and replaced or repaired.

Manual. This manual is provided "as is" without a warranty of any kind, expressed or implied, including, but not limited to, the implied warranty of merchantability and fitness for a particular purpose. The manufacturer has made every effort to ensure the accuracy of the contents of this manual, however, it is possible that it may contain technical inaccuracies, typographical or other errors. No liability is assumed for any inaccuracy found in this publication, nor for direct or indirect, incidental, consequential or other damages that may result from such an inaccuracy, including, but not limited to, loss of data or profits. Please report any inaccuracies found to docs@mikrotik.com.

RouterBOARD 433/433AH

Quick Setup Guide and Warranty Information





Assembling the Hardware

First use of the board:

- Insert the MiniPCI cards;
- Install the board in a case and connect antenna wires, if needed;
- Connect other peripherals and cables;
- Plug in power cable to turn on the board.

Powering

The board accepts powering from either the power jack or the LAN1 Ethernet port:

- direct-input power jack **J801** (5.5mm outside and 2mm inside diameter, female, pin positive plug) accepts 10..28 V DC (overvoltage protection starts at 30V).
- LAN1 Ethernet port **J601** accepts 10..28 V DC input (at the board; higher voltage needed to compensate for power loss on long cables; at least 18V suggested) from **non-standard (passive)** Power over Ethernet injectors (no power over datalines).

The maximum output of the power supply available for extension cards is normally 16W.

Booting process

First, RouterBOOT loader is started. It displays some useful information on the onboard RS232C asynchronous serial port. The serial port is set by default to 115200bit/s, 8 data bits, 1 stop bit, no parity. **Note** that the device does not fully implement the hardware (RTS/CTS) flow control, so it is suggested to try to disable hardware flow control in the terminal emulation program in case the serial console does not work as expected, and if it does not help, make a new cable using the pinout given in the User's manual. The loader may be configured to boot the system from the onboard NAND, and/or from network. See the respective section of User's manual on how to configure booting sequence and other BIOS parameters.

DHCP or BOOTP (configurable in loader) protocols allow the RouterBOARD 433 series board to get an initial IP address, and provide the address of a TFTP server to download an ELF boot image from. It is especially useful for software installation. See the User's manual for more information and protocol details. Note that you must connect the RouterBOARD you want to boot and the BOOTP/DHCP and TFTP servers to the same broadcast domain (i.e., there must not be any routers between them – they must be on the same Ethernet switch).

Extension Slots and Ports

- Three Ethernet ports, supporting automatic cross/straight cable correction (Auto MDI/X), so you can use either straight or cross-over cables for connecting to other network devices. The first Ethernet port accepts 10..28 V DC powering from a passive PoE injector. The other two Ethernet ports **do not** support PoE powering.
- Three MiniPCI Type IIIA/IIIB ports with 3.3V power signaling.
- DB9 RS232C asynchronous serial port.
- microSD card slot for storage expansion (only on RB433AH)

Buttons

- ROS reset hole. While booting, and holding a metal object in this hole (so that it's metal sides short-circuit) will cause RouterOS software to be reset to defaults
- BIOS Loader backup button. Holding the button while booting will cause the backup bootloader to be used.

Operating System Support

Currently tested operating system is MikroTik RouterOS (starting from version 3.4).

Copyright and Warranty Information

Hardware. MikroTikls SIA warrants all RouterBOARD series equipment for the term of one year from the shipping date to be free of defects in materials and workmanship under normal use and service, except in case of damage caused by mechanical, electrical or other accidental or intended damages caused by improper use or due to wind, rain, fire or other acts of nature.

If you have purchased your product from a MikroTik Reseller, please contact the Reseller company regarding all warranty and repair issues, the following instructions apply **ONLY** if you purchased your equipment directly from MikroTik Latvia

To return failed unit or units to MikroTikls you must perform the following RMA (Return Material Authorization) procedure. Follow the instructions below to save time, efforts, avoid costs, and improve the speed of the RMA process. Take into account that all goods have one year warranty.

Instructions are located on our webpage here: **http://rma.mikrotik.com**

Manual. This manual is provided “as is” without a warranty of any kind, expressed or implied, including, but not limited to, the implied warranty of merchantability and fitness for a particular purpose. The manufacturer has made every effort to ensure the accuracy of the contents of this manual, however, it is possible that it may contain technical inaccuracies, typographical or other errors. No liability is assumed for any inaccuracy found in this publication, nor for direct or indirect, incidental, consequential or other damages that may result from such an inaccuracy, including, but not limited to, loss of data or profits. Please report any inaccuracies found to support@mikrotik.com.

WLAN 802.11 b/g/n and *Bluetooth*® v2.1 + EDR Module

FEATURES

- **IEEE 802.11 b/g/n Compliant**
- **Typical WLAN Transmit power:**
  - **+20dBm, 11Mbps, CCK (b)**
  - **+14.5dBm, 54Mbps, OFDM (g)**
  - **+12.5dBm, 65Mbps, OFDM (n)**
- **Typical WLAN Receiver sensitivity:**
  - **–89dBm, 8% PER, 11Mbps**
  - **–76dBm, 10% PER, 54Mbps**
  - **–73dBm, 10% PER, 65Mbps**
- ***Bluetooth* v2.1 + Enhanced Data Rate (EDR)**
- **Increased *Bluetooth* Transmit Power: +9.5dBm Typical**
- **-92dBm typical *Bluetooth*® Receiver Sensitivity**
- **Best-In-Class WLAN and *Bluetooth* Coexistence Technology on a Single-Chip**
- **Enhanced Low Power (ELP™) Technology for Extended Battery Life**
- **On Board TCXO, Power Regulation and U.FL Antenna Connector**
- **Hardware and Software Pre-integration With TI's AM/DM37x (ARM Cortex™-A8), AM18xx (ARM9), and OMAP4™ (ARM Cortex™-A9) Platforms**
- **Software Upgradable for ANT and *Bluetooth* Low Energy**
- **Dimensions: 13mm x 18mm x 1.9mm**
- **FCC/IC/CE Certified**
- **Operating Temperature Range: –40°C to 85°C**

APPLICATIONS

- **Consumer Devices**
- **Industrial and Home Automation**
- **Point of Sale and Point of Purchase**
- **Video Conferencing, Video Camera and VoIP**
- **Medical Devices**
- **Security and Surveillance**

DESCRIPTION

The following product brief applies to LS Research's WLAN + *Bluetooth* module, series name: TiWi. The WLAN + *Bluetooth* chip used is the WL1271 from Texas Instruments.

The WL1271-TiWi is a fully-integrated high performance module offered by LS Research using TI's single-chip WL1271 2.4GHz IEEE 802.11 b/g/n and *Bluetooth* v2.1 + Enhanced Data Rate (EDR) Transceiver. Based on TI's 6th generation WLAN technology and 7th generation *Bluetooth* technology, the solution provides best-in-class coexistence capabilities coupled with TI's Enhanced Low Power (ELP) technology. The WL1271-TiWi is provided as a module to help customers reduce development time, lower manufacturing costs, save board space, ease certification, and minimize RF expertise required. For evaluation and development, various platforms are available which integrate the WL1271-TiWi module, Linux WLAN drivers, BlueZ *Bluetooth* stack, and sample source applications running on a TI host processor (AM/DM37x, AM18x, OMAP4).

The full specification and purchasing of the WL1271-TiWi module can be found on LSR's website (www.lsr.com/tiwi). More information on TI's wireless platform solutions can be found on the Wireless Connectivity Wiki (www.ti.com/connectivitywiki).

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